

PLANKTON COMMITTEE

(D. H. Cushing)

1973

Belgium

(R. de Clerck)

A study of the distribution in space and the evolution in time of fish eggs and larvae of commercial and non-commercial fishes was carried out during 1973. To this aim 43 stations along the Belgian coast were sampled by means of the Dutch type Gulf Sampler. At the same time certain physical parameters such as temperature and salinity were determined. This study shows that the Belgian coast is mainly characterized by the presence of two important commercial species namely:

Clupea sprattus L. and Solea vulgaris L. The larvae of the non-commercial fish Gobius sp. occur also in very great numbers. In addition a few other species: Caranx trachurus (L), Ammodytes lancea Cuv. Platichthys flesus (L), Callionymus lyra (L), Syngnathus sp., Limanda limanda (L), Belone belone (L), Liparis liparis L., Gadus luscus L., Onos sp. and Gasterosteus aculeatus L. appear only sporadically.

Canada

(T. Platt)

A simulation model has been developed of the phytoplankton photosynthesis in the Fraser River estuary under the assumption that only a single independent variable affected the rate of productivity at any one time (University of British Columbia). The analysis shows that light is usually the limiting factor for phytoplankton growth, but that temperature becomes critical in the spring, and that lack of nutrients caused photoinhibition during July and August. A research program is being started to determine the biochemical response of planktonic

organisms to various pollutants including heavy metals and hydrocarbons (University of British Columbia). A lengthy manuscript has been completed on the dinoflagellates of the "Anton Bruun" cruises made during the International Indian Ocean Expedition.

At the Biological Station, Nanaimo, The Great Central Lake project, which is an experimental attempt to enhance the production of food for juvenile salmon, is entering a new phase. The period of nutrient additions has been terminated and the lake is being monitored to study the return to prefertilization conditions.

In another project (Nanaimo) on the plankton photosynthesis in a strongly-stratified estuary, it was found that phytoplankton concentrations occur beneath the halocline. The concentrations are maintained there by entrainment caused by the seaward discharge of freshwater. Under these conditions, light is the limiting growth factor. If the subhalocline populations are exposed to an adequate source of light, their growth is limited by nitrate concentration. In an experimental steady-state system these phytoplankton produced about 200% of their biomass per day, of which 74% was in the form of excreted organic material. A population of heterotrophs 1.9 times that of the autotrophs in biomass was supported and it produced 44% of its biomass per day. This work is being continued to determine if and how the system associated with the halocline might be exploited by fish.

A substantial proportion of the Canadian research on marine phytoplankton has been focussed on the St. Lawrence River-Estuary-Gulf System. Several manuscript reports have been completed on the primary and secondary production studies made in the Gulf in 1969-72 for the JBF program (McGill University).

Ice biota studies from cores collected in the Gulf of St. Lawrence February-March 1973 show that chlorophyll concentrations were significantly higher in the eastern half of the Gulf compared to the West (McGill University). The opposite trend was found for ice nutrients and phaeopigments. Salinities varied from 3 ‰ in the upper section of the ice cores to 10 ‰ in the lowest sections.

In the middle estuary of the St. Lawrence, a three-year program of study is being carried out by the Group interuniversitaire de recherches océanographiques du Québec (GIRQQ) on problems associated with the intense horizontal

and vertical mixing of water masses. To date, attention has been focussed mainly on the identification of the principle sources of variability in both the physico-chemical environment and the plankton populations. A similar study is underway in the fjord of the Saguenay river, which drains into the St. Lawrence.

Work by the Marine Ecology in the St. Lawrence estuary has dealt with the automatic survey of population density of euphausiids using an acoustic technique and with the investigation, again using automatic data acquisition, of the relationship between small-scale fluctuations in phytoplankton biomass and temperature. Preliminary analysis of the results indicates that significant coherence exists between the chlorophyll and temperature fields for length-scales from several km down to 100 m, but that coherence breaks down for smaller length-scales.

Development of automatic survey instruments is underway also in Dalhousie University. A device has been perfected which counts, in situ from a moving ship, the abundance of particles up to about 1 cm in size. Several environmental parameters may also be recorded in situ. The equipment is being used for the study of zooplankton concentrations in relation to thermal micro-structure off Labrador.

In a study of the energetics of a specialised trophic interaction involving two pteropods, Clione limacina and its prey Spiratella retroversa, it has been found that assimilation of nitrogen by the predator is essentially 100% and assimilation of carbon 90%. The ecological growth efficiency is in excess of 50%.

Denmark  
(E. Smidt)

East Greenland

In connection with the ICES "overflow" project a few (5) primary production measurements were performed in the Denmark Strait and the Irminger Sea. Coccolithophorids were sampled throughout the water column at selected stations in the same area.

## West Greenland

The annual routine stramin net samples ( 2 m ring diameter,  $\frac{1}{2}$  hour oblique hauls from ca. 50 m depth) were taken together with hydrographic observations on three east-west standard sections in the Davis Strait in June-July and on a standard station off Godthaab from May to October. In total 21 samples were taken. Displacement volumes were measured. Fish eggs and larvae and invertebrates were sorted and counted.

## Federal Republic of Germany

(J. Krey)

### 1. Institut für Meeresforschung an der Universität Kiel

The long-term observations on the standing stock of phytoplankton and zooplankton in relation to environmental factors at the fixed station Boknis Eck in the western Kiel Bight were continued for the 17th year. The monthly measurement of temperature, salinity, oxygen, total phosphorus, seston, chlorophyll a and protein content in water samples from 6 standard depths provide an unique volume of data for the demonstration of seasonal fluctuations in this area.

The observations have been intensified since 1972 within the framework of another project sponsored by the German Research Association concentrating mainly on the chemical exchanges between water and sea-bottom. At a nearby station temperature, salinity, oxygen, phosphate, nitrate, nitrite, ammonia, silicate, seston, chlorophyll a, particulate N, particulate C, the caloric content of seston, phytoplankton and zooplankton abundance and species composition were measured at fortnightly intervals. In addition to these observations, the measurement of dissolved C and of primary production using the  $^{14}\text{C}$  in situ technique were started in 1973. The process of seston and plankton sedimentation was studied with the help of specially developed receptacles for sinking particles.

Further studies dealt with pollution problems in relation to phytoplankton ecology. An experimental investigation on the influence of oil on phytoplankton growth was completed.



## 2. Biologische Anstalt Helgoland

The Department of Biological Oceanography continued its year-round measurements of hydrographical, chemical and planktological parameters at Helgoland Roads. Nutrient analyses carried out three times a week covered phosphate, nitrate, nitrite, ammonia and silicate. Samples of surface water for the qualitative and quantitative estimation of plankton were collected daily between March and October from 4 German lightships in the southern German Bight.

The planktological and chemical investigation of the Waddensea water between the island of Sylt and the mainland was intensified. Besides hydrographical parameters, nutrients ( $\text{PO}_4$ ,  $\text{NO}_3$ ,  $\text{NO}_2$ ,  $\text{NH}_4$ ,  $\text{SiO}_2$ ), phytoplankton and seston content and composition were analysed twice weekly at low and high tide. The changes in these parameters during the tidal cycle off List/Sylt were investigated with RV 'Friedrich Heincke' for one week in June.

The studies on the distribution and ecology of Noctiluca miliaris were continued in various coastal water areas of the German Bight. The biology of appendicularians and copepods was studied in culture experiments. Special attention was paid to food uptake and conversion rates under controlled conditions.

## 3. Institut für Küsten- und Binnenfischerei Hamburg

Routine investigations on the plankton composition in the Elbe estuary were continued.

## 4. Institut für Hydrobiologie und Fischereiwissenschaft, Universität Hamburg

Zooplankton analyses in sampling areas of the Norwegian Sea and North Atlantic were continued, the main points of interest being vertical migration and microdistribution.

## 5. Institut für Meeresforschung, Bremerhaven

By means of a new near-bottom water sampler the influence of current speed on the turbidity in near-bottom water was investigated in the southern North Sea. Research on the identification of planktonic larvae of brachyurous crustacea found in the North Sea was continued.

Finland  
(A.Niemi)

Institute of Marine Research, Helsinki

Phytoplankton and primary production

- a) Investigations on phytoplankton, primary production ( $^{14}\text{C}$ , in situ, and in incubator in constant light and temperature), total phosphorus and nitrogen, and environmental parameters were made in unpolluted sea areas at 4 coastal stations: Orrengrund (mid part of the Gulf of Finland), Tvärminne (entrance to the Gulf of Finland), Kaskinen (northeastern part of the Bothnian Sea) and Ulkokalla (Bothnian Bay). Samplings were made every second or third week; during the ice-period more sporadic samples were taken.
- b) During the cruises (June-November) with RV "ARANDA" measurements of chlorophyll-a and the primary production ability ( $^{14}\text{C}$ , incubator, constant light and temperature), and sampling of phytoplankton were made at international stations in the Baltic proper, Gulf of Finland and Gulf of Bothnia.

Zooplankton

Zooplankton sampling (Hensen net, mesh size 150  $\mu\text{m}$ , vertical haul: 25-0 m) has been continued at the following coastal stations: Orrengrund (1967-), Tvärminne (1966), Seili in the Archipelago Sea (1966-), and Krunnit in the north-eastern part of the Bothnian Bay (1966-). Sampling has been performed three times a month (once a month during the ice-period).

During the cruises with RV "ARANDA" zooplankton has been sampled (Nansen net, mesh size 150  $\mu\text{m}$ , vertical hauls, 25-0, 50-25 m) at international stations in the Baltic proper, Gulf of Finland and Gulf of Bothnia.

Institute of Radiation Physics, Helsinki

Studies on primary production ( $^{14}\text{C}$  in situ, and in incubator in constant light and temperature) and phytoplankton have been made in the Loviisa area (mid part of the Gulf of Finland), and at Olkiluoto (off Eurajoki, Bothnian Sea) in order to get background data from these two areas, where atomic power

plants are to be built. One or two samplings a month have been made during the ice-free period.

National Board of Waters, Water Research Office

Phytoplankton and physicochemical parameters were measured twice a year, at the beginning of March and in early August, at about 30 stations in the Gulf of Finland and the Gulf of Bothnia.

Tvärminne Zoological Station

Phytoplankton, chlorophyll-a, primary production ( $^{14}\text{C}$ , in situ), total phosphorus and nitrogen, and environmental parameters have been studied in the Tvärminne-Pojoviken area. Samples were taken 1-2 times a month and once a month during the winter season.

Helsinki City Water Conservation Laboratory

Phytoplankton and zooplankton (vertical series, mesh size 50  $\mu\text{m}$ ), were sampled and primary production ( $^{14}\text{C}$ , in situ) and environmental parameters were measured in the archipelago waters off Helsinki and Espoo twice a month during the ice-free period. Samples were taken at several stations extending from the severely polluted inner bays to the unpolluted area outside the archipelago.

France

(L. Marteil)

I - Institut scientifique et technique des Pêches maritimes -

1°) Phytoplankton

L'étude qualitative et quantitative du phytoplancton a été poursuivie dans les divers centres de production conchylicole. Dans le bassin de Marennes-Oléron, 77 espèces de bacillariales et 23 espèces de dinophycées ont été identifiées ; l'évolution des pigments chlorophylliens y a été suivie.

## 2°) Zooplancton

L'important matériel récolté dans le golfe de Gascogne en 1971 et 1972, inventorié en ce qui concerne les copépodes, les méduses, siphonophores, salpes, doliolles, chaetognathes, a fait l'objet en 1973 d'une publication sur les copépodes. L'étude des euphausiacés et mysidacés récoltés le long de la côte des Landes a été réalisée.

Les populations larvaires d'huîtres et de moules ont été étudiées au moment de leur reproduction dans les divers secteurs d'élevage de ces mollusques.

## 3°) Ichthyoplancton

Le principal thème de recherche a porté sur les oeufs et larves de poissons commerciaux capturés au cours de trois campagnes : février, mai et août. Ce travail, poursuivi depuis une dizaine d'années a pour but de donner des indications précises sur l'importance de la ponte des poissons en vue des prévisions de pêche. Cependant en 1973, le secteur habituellement prospecté n'a pas pu être couvert en totalité.

Les oeufs et larves de clupéidés ont fait l'objet d'une étude spéciale (réf. Comité des poissons pélagiques (sud)) en vue de déterminer le stock total d'oeufs pondus sur une frayère précise. A ce travail a été ajoutée la détermination des oeufs et larves de Scomber scombrus, Argentina sphyraena, Pagellus centrodontus, Solea solea, Microchirus variegatus, Pegusa lascaris, Buglossidium luteum, Merluccius merluccius, Trisopterus minutus, Micromesistius pontassou, Onos mustela, Tripla gurnardus, Ammodytes lanceolatus. Pour chacun de ces poissons les frayères ont donc été localisées. Une étude sur les post-larves a également été abordée afin de connaître le devenir exact des jeunes larves au cours de leur croissance ainsi que leur taux de mortalité.

## II - Travaux du laboratoire de biologie animale (Plancton) Marseille - Atlantique

Regroupement des résultats (taxonomie, écologie) obtenus pour les Décapodes pélagiques dans l'Atlantique eurafricain depuis 1967 (ABBES et CASANOVA).

Etude du plancton récolté par la "Thalassa", en 1971, dans l'upwelling mauritanien (biomasse, espèces caractéristiques) (J.P. CASANOVA : communication à la 2ème conférence "Analyse de l'écosystème des upwellings").

### Atlantique et Méditerranée

Données sur la production primaire dans le secteur sud-occidental de la Méditerranée, en fonction du courant atlantique (M.L. FURNESTIN).

Effets de la nocivité de solutions acides de sels de fer (résidus de la fabrication du dioxyde de titane) sur le plancton marin : toxicité à court terme, étudiée sur des organismes phyto et zooplanctoniques; toxicité à l'égard du développement larvaire de crustacés décapodes; toxicité induite: accumulation de métaux par le phytoplancton et dans une chaîne pélagique (P. LASSUS, coll. I.S.T.P.M.).

Révision de la systématique des Thécosomes d'après la structure de la coquille et la morphologie du manteau. Aspect phylogénétique (J. RAMPAL).

Histologie et ultrastructure des yeux de Chaetognathes. Relations écologiques (F. DUCRET).

### Méditerranée

Répartition quantitative et spécifique des Chaetognathes dans le secteur sud-occidental du bassin oriental en fonction de la bathymétrie et des conditions hydrologiques (M.L. FURNESTIN).

Zooplancton du golfe du Lion au cours d'un cycle annuel. Relations avec le milieu hydrologique (C. FALKE).

Ecologie expérimentale : comportement nutritif des Copépods Centropages typicus, Temora stylifera et Clausocalanus arcuicornis vis à vis de différentes espèces phytoplanctoniques (J. MAZZA).

Propositions en vue de la standardisation des engins de récolte et des méthodes d'étude de l'ichthyoplancton (dans le cadre C.I.S.M. et E.C.M., Symposium de Palma de Majorque, oct. 1973, M.L. FURNESTIN).

### Iceland

ICELAND (Thórunn Thórdardóttir)

#### Phytoplankton

Measurements of primary production in Icelandic waters by means of  $^{14}\text{C}$  technique were carried out at the standard depths 0, 10, 20 and 30 m. In addition, repeated in situ measurements were made during 48 and 30 hour



periods at two localities (off Kögur and off Berufjördur, respectively). As previously, samples for quantitative analyses of phytoplankton were collected wherever productivity was measured. Chlorophyll a was ordinarily determined in samples from 10 m but where in situ measurements were made, chlorophyll a was measured at all levels.

During the period 5/6 - 16/6 primary production and chlorophyll a were measured at 58 stations in the waters off the northwest, north and northeast coasts of Iceland.

During the periods 9/3 - 16/3, 11/4 - 14/4, 13/5 - 16/5 and 1/6 - 5/6 production was measured at 24 fixed stations (Háfadjúp-Snaefellsnes program) in the waters off southwest and south Iceland. Chlorophyll a was also determined in all but the first survey.

During the period 15/8 - 5/9 primary production and chlorophyll a measurements were made in the near shore and oceanic waters northeast, east and southeast of Iceland (Overflow-program). In the southeastern coastal area and in the area of the channel nearest to the Icelandic slope the measurements were repeated two to three times.

#### Zooplankton (Ingvar Hallgrímsson)

Zooplankton sampling was carried out at 242 stations in 1973 in the following surveys:

In April 40 stations were worked off the S-, SW- and W coast of Iceland and in May 24 stations were worked in the same area.

In May 70 stations were also worked in the Irminger Sea and East Greenland waters.

In June 92 stations were worked off the S-, W-, N- and NE coast.

In August 16 stations were worked off the SE coast of Iceland.

The sampling was carried out with a Hensen net from 50 - 0 m. and Icelandic High Speed Samplers from two different depths.

As previously the continuous plankton survey between Reykjavik and New York and Reykjavik and Leith, worked in cooperation with the Oceanographic Laboratory, Edinburgh, were still in progress.

Ireland  
(F.A. Gibson)

Since 1967, approximately once a fortnight, samples of fish eggs have been taken by tin-townetting at one or more coastal centers. To date 19 stations on the south and west coasts have been sampled, chiefly during the months of May and June, including estuaries, bays, inshore waters and open water up to 90 fathoms. Results have been published up to 1971.

This routine sampling will be continued and the results of it will be published as appropriate.

Netherlands  
(P. Korringa)

As in previous years plankton samples have been collected for various purposes in the year 1973 by the Dutch research ships operating in the North Sea.

The RV "Tridens" and "Willem Beukelsz" participated in the international herring larvae programme with cruises in the central and southern North Sea. Other surveys were made for larvae of cod and brown shrimp in the southern North Sea. The influx of herring larvae into Dutch coastal waters was monitored during cruises of RV "Stern" and "Willem Beukelsz". Specially designed nets to catch sole larvae were used during experimental surveys in the Waddenzee.

The phytoplankton in the coastal water off the provinces Noord-Holland and Zuid-Holland was studied at regular intervals. Samples taken at different distances from the coast were analysed qualitatively and semi-quantitatively to study the succession pattern, and more specifically to watch out for dinoflagellate blooms which might affect the mussels in Zeeland and in the Waddenzee. Though dinoflagellates appeared in larger numbers late in summer, the mussels were not affected perceptibly.

From all the data obtained there were no clear indications that either temperature or salinity controlled the succession pattern.

Norway

(G. Berge, F. Beyer)

1. Institute of Marine Research

Phytoplankton (G. Berge)

1. The primary production rates and the standing stock of phytoplankton were measured at the coastal banks west of Norway, with the emphasis on the nursery grounds of cod and herring. The programme is a long-term monitoring of environmental conditions during and after hatching of the fish larvae and includes also light and turbidity measurements and particle size frequency analysis. The primary production rates per unit of chlorophyll at standardised conditions (PI) was used to compare local and annual changes in the activity of the producing plankton, 9-28 April 1973. Inst. Mar. Res.
2. A survey was made of 5 fjords in Northern Norway in connection with pollution studies. Nutrients, primary production, chlorophyll and particle volumes and surfaces were measured. May 1973, Inst. of Mar. Res.
3. A one year programme commencing March 1973 was worked in the fjords surrounding Bergen. The Primary production, chlorophyll, water transparency and particle size frequency analyses were carried through at a number of stations sampled monthly. The programme is operated jointly with the University of Bergen which covers the physical and chemical oceanographical part.  
Inst. of Mar. Res. and Geophysical inst. U. of Bergen.
4. On a survey of Kattegat, Skagerak and the coastal banks of Western Norway during November/December 1973, with the primary aim to investigate the load of organic material on the Baltic Current, the primary production, chlorophyll and particle size frequencies were analysed and the particle distributions were continuously recorded. Inst. of Mar. Res.
5. Experimental analyses on effects of some organic pollutants on the photosynthetic activities of phytoplankton and the ATP levels in microorganisms were carried through. Inst. of Mar. Res.



### Zooplankton (K.F. Wiborg)

1. Sampling was continued at the permanent oceanographical stations along the coast of Norway, West Spitsbergen and at Station M. The material is worked up and data listed on cards for computer processing.
2. The short-cut method as used for the estimation of biomass of zooplankton has been tested against a subsampling method and a report is in preparation.
3. No salps were observed in 1973.
4. Investigations related to commercial fishery for zooplankton and krill (euphausiids) were carried out in coastal and offshore areas of West Norway in Spring and Autumn. For zooplankton, Clarke-Bumpus plankton samplers, Juday nets and a commercial plankton trawl were used. The zooplankton was less abundant than in 1972, concentrations not exceeding 2 ml/m<sup>3</sup> in the upper 20 m. Fishermen also complained of small catches.
5. In fjords, south of Bergen, krill were recorded with echosounders in April, June and October both during day and night and caught with a fine-meshed pelagic trawl near the surface at night. The catches were below expectation and investigations are continued to correlate the echo traces with the actual abundance, and to improve the catching method and gear.
6. Various methods have been tried for conservation and processing of zooplankton and krill for fish feed and human consumption.

### University of Bergen, Biological Station, Espegrend

Common to all plankton sampling in 1973 was an emphasis on the the variations on standing stock in Norwegian fjords and the causes which lie behind them.

#### Phytoplankton

1. In Raunefjorden and Korsfjorden, phytoplankton samples were collected regularly in order to study species composition. Not quantitative.

#### Zooplankton

1. Regular sampling in Lindåspollene was continued, using the WP-2 net. (U. Lie).
2. In Korsfjorden, fortnightly sampling was continued at one fixed station with a plankton net designed to take a Longhurst-Hardy plankton sampler, the aim being to record vertical distribution of the major components of zooplankton. Calorimetrical and biochemical studies have been included (J.B.L. Matthews).
3. The routine sampling of phytoplankton and zooplankton in the Ryfylke has been continued, the aim being to study the effects of fresh water run-off regulation (A. Fosshagen).
4. Investigations on the systematics and biology of bottom-living copepods were continued on material from Skjomen in N. Norway (A. Fosshagen).

3. University of Trondheim, Biological Station, and the Institute of Marine Biochemistry, (formerly the Norwegian Institute for Seaweed Research)

Phytoplankton

1. Qualitative and quantitative studies of chloroplast pigments of phytoplankton in the Tronheimsfjord were carried out and much time has been devoted to investigating the potentiality of dialysis culture techniques for growing micro algae. The method can be used for monitoring the capacity of fjord water for supporting algal growth and to estimate toxicity of heavy metals to phytoplankton (A. Jensen)

2. Work is in progress with regard to studies of the production of protein and carbohydrates (cellular and extra cellular) and accumulation of N and P in marine diatoms (S. Mykkestad).

3. At the University of Rhode Island, nutrient limitation was studied using in situ dialysis cultures. At the Scripps Institute of Oceanography, N-, P- and Fe-limitation was studied in batch cultures (E. Sakshaug).

Zooplankton (T. Strömberg)

1. In the Trondheimsfjord, seasonal variations in the zooplankton were studied, particular attention being paid to its relation to hydrography and to the zooplankton diversity.

2. Detailed studies were carried out on the chaetognaths of the fjord.

4. Statens Biologiske Stasjon, Flødevigen

No plankton research was carried out in 1973.

5. Tromsø Museum, Marinbiologisk Stasjon, Tromsø

Zooplankton (S. Skreslet)

1. The taking of bi-monthly routine stations in some fjords in Troms and Finmark was continued. Displacement volume assessments are being based on divided vertical hauls with 500  $\mu$  mesh Juday net.

2. Looking particularly for pelagic fish eggs and larvae, coastal waters of Nordland, Troms and Finmark were sampled by means of Bongo net and Zaitsev hyponeuston net.

3. In the Skjomen-Ofotenfjord, the routine sampling was continued with bi-monthly cruises till May. Results are in press.

4. A preliminary report has been worked out on the occurrence and vertical distribution of fish eggs and larvae in the Skjomen fjord.

6. University of Oslo, Institutt for Marin Biologi og Limnologi

Phytoplankton

1. Phytoplankton surveys

a) The investigation of the spring phytoplankton in the spawning areas of cod and herring (Lofoten to Møre) was continued, in collaboration with the Marine Research Institute of the Fisheries Directorate, Bergen. This investigation is part of the Norwegian IBP/PM programme (I. Nygaard, T. Engerud).



- b) Phytoplankton was examined as part of oceanographic surveys carried out in connection with hydroelectric power-plant projects. Samples from two of these surveys have been worked up and preliminary reports prepared : (i) from Skjomen, near Narvik (B. Schei); (ii) from the Hardangerfjord (A. Dick, T. Braarud). A third survey, in the Ryfylke Fjords, is in progress ( I. Nygaard, T. Braarud).
- c) An all-year survey of the near-surface phytoplankton in the Korsfjord, near Bergen, and a survey of the autumn and winter phytoplankton in the Hardangerfjord, have been undertaken (K.-E. Berg).
- d) A report is in preparation on the summer phytoplankton of Nordåsvatn, a bay near Bergen (K. Tangen).

## 2. Special phytoplankton studies

- a) Taxonomic studies on coccolithophorids, by means of transmission and scanning electron microscopy, were continued (K.R. Gaarder, B.R. Heimdal).
- b) Morphology, taxonomy and distribution of marine plankton diatoms were studied by means of light and electron microscopes (G.R. Hasle).
- c) Further experiments were carried out on the primary productivity and photosynthesis of nannoplankton flagellates (J. Throndsen).
- d) Growth of marine plankton diatoms under silicate limitations was investigated (E. Paasche).
- e) Enrichment experiments and other studies of the possible role of silicon as a limiting nutrient in the Oslofjord were continued (B.J. Langemyr).
- f) An investigation was concluded and a preliminary report prepared on the effect of elevated temperatures on the growth of the phytoplankton of the Oslofjord (E. Dahl).
- g) Chemical studies were continued on the compounds produced by photosynthesis in marine algae (E. Føyn and S. Hanneborg).
- h) Investigations were carried out on the uptake of nutrients in plankton algae (E. Føyn and B. Reusch Berg).

### Programme for 1974

Investigations mentioned above (1, a and b; and 2, a-e) will be continued.

The following special studies will be undertaken:

- 1) Primary production measurements on various size fractions of phytoplankton in the Oslofjord (J. Throndsen) and in the Tromsø area (J. Thorndsen, B.R. Heimdal).
- 2) An investigation of variations in diatom shell morphology and silica content brought about by changes in growth conditions (G.R. Hasle, E. Paasche, others).

### Zooplankton

- 1. A Master's thesis on the concentration of heavy metals in selected species of zooplankton from the Oslofjord and coastal waters outside was completed (L. Kirkerud).
- 2. Studies on the neuston-hyponeuston in the Oslofjord were initiated (T. Schram).

Poland

(W. Mańkowski)

Plankton investigations in the area of the southern Baltic in 1973 were conducted by the Sea Fisheries Institute at Gdynia, the Oceanographic Institute at the Gdansk University at Gdynia, and the Department of Oceanography of the Academy of Agriculture at Szczecin.

Plankton samples were collected as follows:

phytoplankton - by means of the standard Copenhagen net, gauze no. 25 and a sampler of 9 litre volume,

zooplankton - by means of the standard Nansen net, gauze no. 8, the standard Hensen net, gauze no. 3, and the 5 litre-sampler.

The samples were taken once a month from the Bay of Puck/Baltic coastal waters/ and 4 times in the year from the open waters of the sea. For the phytoplanktonic studies of the open waters 132 samples for qualitative and 172 ones for quantitative examination were collected at following depths:

For qualitative analysis	For quantitative analysis
from the bottom to 70 m depth	at 5 m depth
" 70 m to 50 m depth	" 10 m "
" 50 m " 30 m "	" 15 m "
" 30 m " 15 m "	" 20 m "
" 15 m " the surface	" 30 m "
	" 40 m "
	" 50 m "
	" 60 m "

For zooplankton studies 178 samples were taken with the Nansen net from the bottom to the surface at every 20 m depth, and 267 samples - with the Hensen net by 3 times repeated hauls carried on from the bottom to the surface.

The phytoplankton samples from the Bay of Puck: 6 taken in June and 7 in September, are being worked by the planktologists of the Gdansk University.

The results concerning the qualitative and quantitative composition of phytoplankton that has been examined by the biologists of the Sea Fisheries Institute, are as follows:

The phytoplankton composition in 1973 was made up of:

18 species from the group of Dinoflagellatae,

1 " " " " of Chrysophyceae,

1 " " " " of Silicoflagellatae

15 " " " " of Cyanophyceae,

46 " " " " of Bacillariophyceae,

9 " " " " of Chlorophyceae.

The greatest differentiation relative to species was found in the area of the Arkona Deep. The North Sea species characteristic for salt water influxed from the North Sea to the Baltic, though occurring in great numbers immediately after the influx 1972, did not continue to be observed in 1973. Instead of these the occurrence of a species peculiar for polluted waters, Nitzschia palea was captured. This species has considerably widened its area of occurrence in the southern Baltic towards the south and east.

Quantitative changes in the composition of the southern Baltic phytoplankton during the year 1973 presented themselves as follows.

In the winter season the most numerous species was Kirchneriella obesa the number of which amounted to 252 million of cells per one cubic metre at 0.5 m depth at station G<sub>2</sub> of the Gdansk Deep.

In spring the most numerous were:

Kirchneriella obesa:  $5166 \times 10^6$  cells/m<sup>3</sup> at 0.5 m depth in the Gdansk Deep,

Skeletonema costatum:  $1706 \times 10^6$  cells/m<sup>3</sup> at the same depth in the Gdansk Deep,

Chaetoceros borealis:  $256 \times 10^6$  cells/m<sup>3</sup> at 0.5 m depth at station B<sub>1</sub> of the Bornholm Deep,

Microcystis aeruginosa:  $210 \times 10^6$ /m<sup>3</sup> at 30 m depth in the Gdansk Deep.

In the summer season most numerous represented were the following species:

Kirchneriella obesa:  $1470 \times 10^6$  cells/m<sup>3</sup> at 10 m depth in the Bornholm Deep,  
Microcystis aeruginosa:  $821 \times 10^6$  cells/m<sup>3</sup> at 0.5 m depth in the Gdansk Deep,  
Anabaena spiroides:  $936 \times 10^6$  cells/m<sup>3</sup> at 10 m depth in the Gdansk Deep.

In the autumn the following species dominated:

Dictyosphaerium ehrenbergianum:  $455 \times 10^6$  cells/m<sup>3</sup> at 5 m depth at station A,  
in the Arkona Deep,  
Kirchneriella obesa:  $349 \times 10^6$  cells/m<sup>3</sup> at 5 m depth in the Gdansk Deep.

On comparing the amounts of phytoplankton contained in 1 m<sup>3</sup> of water in the area of the Gdansk Deep as they were in 1972 and 1973 it may be said that in 1973 the general phytoplankton biomass was 3 times that from 1972.

The planktologists of the Gdansk University dealt with the qualitative and quantitative composition of phyto- and zooplankton deriving from the areas of Bear Island and Hornsund (south Spitsbergen). There the samples were taken with Hensen plankton net (hauls from the bottom to the surface) as well as with Copenhagen net (vertical hauls from the bottom to the surface). Sampling was carried out twice during the year: first in late spring (June), when 12 samples were taken and another time in early autumn (September), when 14 samples were collected. Bringing the analyses of these samples to the end and working on their results is foreseen for 1974.

Besides the materials referred to above 23 plankton samples were taken in June and 38 ones in September along the route of the vessel from Sund to Spitsbergen in order to estimate the composition and distribution of phytoplankton of the surface waters. The sampling was accomplished by means of a speed-sampler (type MFO and Instr. Corp. USA). The materials referred to are actually being analysed.

Moreover, in 1973, an analysis was made concerning the distribution of the pelagic larvae of the species Branchiostoma senegalense together with the analysis of the composition of its population with respect to the size and

number of individuals in relation to some ecological factors such as water temperature, depth, etc. The research was carried out on the basis of the materials collected in the period of 1967-1970 on board the research vessel "Wieczno" belonging to the Sea Fisheries Institute.

The Department of Oceanography at the Academy of Agriculture at Szczecin dealt in 1973 with following plankton problems:

1. Estimation of the zooplankton biomass and the eliminating role of zooplankton relative to the phytoplankton. Materials were sampled 4 times during the year 1973. The biomass was determined by the aid of standards for particular species (chiefly of crustaceans). In a series of experiments conducted under laboratory conditions at various temperatures the grade of grazing phytoplankton by zooplankton was attempted to be established.
2. Evaluation of the energetic value of zooplankton and its variation in the annual cycle.

In 1973 the collection of materials was finished, the necessary apparatuses completed, the methods worked on and the analyses initiated.

Portugal

(José de Ataíde)  
(Manuel Sobral)

Laboratoire de Biologie (Plancton) de L'Institut Hydrographique:

- 1) Analyse qualitative et quantitative des récoltes de zooplancton.  
Évaluation volumétrique du plancton. Études de productivité  
(méthode du  $^{14}\text{C}$  et déterminations des concentrations de chlorophylle a par spectrophotométrie de fluorescence)
- 2) Continuation des campagnes saisonnières sur la côte portugaise.  
Réalisation de quatre croisières concernant études hydrologiques et planctoniques.



Spain  
(J. Corral)

Instituto de Investigaciones Pesqueras

The study of phytoplankton obtained in continuous sampling during "Sahara II" cruise has been continued.

Samples of the "Atlor II" cruise in the upwelling areas off NW Africa have been analysed. The principal aim is the distribution of primary production as well as pigments (spectrophotometric and fluorometric analysis). The methodology on the pigments determination by fluorometric techniques has been revised.

Experimental laboratory cultures of Skeletonema costatum, Asterionella japonica, Thalassiosira decipiens, T. rotula, Phaeodactylum tricornutum, Chaetoceros sp., Leptocylindrus sp., Phaeodactylum cornutum, Tetraselmis striata and other ones have been carried out.

Mixed cultures with predominance of Navicula, Asterionella, Thalassiosira and Skeletonema have been obtained from net samples from the Cadiz Bay. Studies on influence of photosynthesis and organic matter decomposition in the balance of CO<sub>2</sub> system have been made.

The study on zooplankton gathered in "Sahara II", "Atlor II" and "Maroc-Iberia I" cruises has been continued. The aim of this study is to relate the distribution of zooplankton biomass with the primary production from W and NW of Cabo Blanco to the SW. In the above samples the study of copepods was finished. 239 species were counted, 40 of them were new records for this area. In the same samples, studies on systematic and distribution of Euphausiidae and spiny lobster larvae have been made. A study of the classification of fish larvae has been started.

Systematic studies on Appendicularia, Thaliacea and Gastropoda in "Sahara II" and "Atlor II" samples has been made.

Studies on Salpidae Doliolidae and Lamellibranchiata larvae off the Barcelona and Castellon waters have been made, as well as the composition of zooplankton in polluted waters in Barcelona harbour.

Experimental studies on feeding, respiration and excretion rates in relation with temperature were made on Centropages typicus, Temora stylifera, Calanus helgolandicus, Eucalanus sp., Euchirella rostrata, Salpa democratica and some Decapoda larvae.

A study of the annual populations cycle on Acartia in the Ria de Vigo was finished.

Theoretical ecologic work on spacial distribution has been made by computer simulation of different environmental conditions.

#### Instituto Espanol de Oceanografia

Investigations on the biomass of phytoplankton and zooplankton, primary production, distribution of pigments and nutrients in the cruises of February and August 1973 (programme CINECA) in the upwelling areas off NW Africa have been continued.

Work was continued in selection of Chaetognatha and Amphipoda on samples taken at several places in Canary Islands for studies of annual cycles.

In 1973 a new oceanographic Laboratory in Balearic Islands (Palma de Mallorca) was inaugurated. The future programme of work in planktology is mainly devoted to ichthyoplankton and phytoplankton.

Studies on annual cycle of Appendicularia in Mediterranean Sea have been continued during 1973.

In Ria de Arosa, studies on spawning, growth and filtration rates under different experimental conditions of some Mollusc of commercial value (Ostrea edulis, Venerupis pullastra, V. decussatus, Mytilus edulis) were continued. For this programme of work, mono-specific cultures of unicellular algae (genera: Tetraselmis, Isochrysis, Monochrysis, Dicronema and other ones) have been continued, increasing and improving the material and methodology.

Studies on spawning and survival of planktonic stages of mussels have been made with different concentrations of drain water from pulp mill factory.

Sweden

(A. Lindquist)

Skagerrak and Kattegatt

Zooplankton samples have been taken with nets throughout the year. During March and April a survey was made in the Skagerrak for immigrating eel larvae (Isaacs Kidd Midwater Trawl) and during October and November a survey was made in the Kattegatt and Skagerrak for herring larvae (Gulf III sampler).

Baltic Proper and Bothnian Sea

During 1973 the extensive program for investigation of primary and secondary production has continued (see Administrative report 1972). Throughout the year primary production has been measured with the  $^{14}\text{C}$  method, phytoplankton has been sampled (for calculations of biomass and production), the chlorophyll content has been analysed (trichromatic method) as well as the chemical composition.

Zooplankton has been regularly sampled in the Baltic proper and in the southern parts of the Bothnian Sea. In the latter area the investigations started in 1970 with sampling every fortnight as long as ice conditions permitted it.

Ichthyoplankton has been investigated in the Baltic proper and during the autumn in the central Bothnian Sea. The number of eggs and larvae (of cod and sprat) are used for estimations of the strength of the year class. In the case of cod it seems to be a good year class 1973.

United Kingdom

England (D.S. Tungate)

A Offshore surveys

Three international herring larvae surveys were carried out during the year and the results have been reported to the Herring Committee in greater detail. The areas surveyed were:

- 1 The Southern Bight and Eastern Channel in January. Herring larvae were found in small numbers on 43 of the stations.

- 2 Shetland and Outer Hebrides in September. Herring larvae production seemed to be about average for recent years.
- 3 The western central North Sea (Aberdeen to Dowsing) in September and October. Considerable numbers of herring larvae were found off the Yorkshire coast, 2-3 times more than in the previous year.

These herring larvae surveys were made with the Lowestoft 50 cm plankton sampler which was fished with a 0.275 mm aperture mesh and a nosecone which had a 20.3 cm opening.

A survey was made of the western English Channel between Portland Bill and the Scilly Isles in April using the standard Lowestoft 50 cm encased sampler to determine the extent of the pilchard and mackerel spawning.

#### B Inshore surveys

Four inshore surveys were made along the English east coast in March, April, June and September, covering an area from Berwick to North Foreland. The aim was to identify inshore spawning grounds of fish from distributions of eggs and larvae. A Lowestoft 50 cm unencased plankton sampler fitted with a 0.275 mm mesh and a 20.3 cm aperture nosecone was used.

Temperature, salinity, percentage oxygen saturation, turbidity, chlorophyll and pH of the sea water was monitored continuously throughout each of these surveys and the results recorded automatically on to a chart recorder.

Periodic surveys were also carried out in the Flamborough area of the east coast of England, using an unencased Lowestoft 50 cm plankton sampler to collect plaice larvae prior to settlement in Filey Bay.

#### Nanoplankton studied

Nanoplankton was collected on three distant-water voyages to the Barents Sea and Spitsbergen areas in March, June and August. A Turner fluorometer was used to continuously monitor chlorophyll in the surface waters. Cultures were prepared, samples filtered for spectrophotometry and direct preparations for electron microscopy were made. Light microscope examination, including photography of samples, was done as opportunity arose.

Scotland (J.A. Adams)

1. Marine Laboratory, Aberdeen (DAFS)

As in previous years the research vessels from the Marine Laboratory have surveyed various parts of the northern North Sea (north of  $56^{\circ}\text{N}$  and in particular north of  $57^{\circ}\text{N}$ ) and the continental shelf west and north of Scotland. One survey was to the Faroe area (July) and one to the Rockall area (March). Surveys of the Firth of Clyde and of Loch Linnhe and Loch Eil have been continued, while Loch Ewe has continued to be an important area for experimental investigations. The main samplers used were again the Dutch version of the Gulf III with a mesh aperture of  $250\text{ }\mu\text{m}$ ; the Loch Ewe net -- a double net with a mouth diameter of  $0.5\text{ m}$  and mesh apertures of  $250\text{ }\mu\text{m}$  and  $69\text{ }\mu\text{m}$  for the inner and outer nets respectively; the International Standard net and the Icelandic High Speed Sampler. Tow nets with no exposed metal parts were used for obtaining plankton samples for the study of heavy metals. Some aspects of the work are described briefly below.

Standing stock investigations. Chlorophyll a, particulate organic carbon and nitrogen, and zooplankton dry weight data have been collected on suitable cruises. Some of this data (chlorophyll a and zooplankton dry weight for certain cruises) will be published in Annales Biologiques. The computer processing of previous data has continued (J.A. Adams, J.H.A. Martin, W.B. Hall, I.E. Baird, J. Dunn).



Routine monitoring for toxic dinoflagellates etc. In 1973 80 samples, taken with the International Standard Net, from Scottish Inshore waters were examined for the presence of those Dinoflagellates which have, in the past, been associated with mass mortalities of marine organisms and/or which are known to be capable of toxin production. One record was obtained, that of small numbers of G. excavata (Braarud) Paloch at sub square D20a on the 19th July.

In September 1973 the Laboratory received two reports of discoloured water, one from off Horse Island, Loch Broom, Ross-shire and one from off Loch Inver in Sutherland. The first of these incidents was caused by very high numbers of Ceratium tripos and Dinophysis acuta. Analysis and specific identification of a sample from the second incident was not possible, because of inadequate preservation, but it is likely that the causative organism was a Gymnodinium. In neither case were there any associated sightings of dead fish or other marine organisms.

Inshore and coastal surveys. The descriptive work at Loch Linnhe and Loch Eil has continued in relation to the study of the effects of the pulp mill effluent. The series of Firth of Clyde surveys has now been completed and the data covering the years 1970-74 (and in particular 1972-74) is now being evaluated (D.V.P. Conway and J.A. Adams).

Fish eggs and larvae. The larval herring sampling programme was the same as in previous years, i.e. the Ballantrae Bank in the spring, along the outer part of the continental shelf west of Scotland in the autumn, and participation in the international survey of herring larval production in the North Sea. (A. Saville, D.W. McKay). Two cruises (June and August) investigated the distribution of sprat eggs and larvae off the east coast of Scotland, while samples taken for other purposes were used to give data for May, July and September (R.S. Bailey, D.W. McKay).

Plaice eggs and larvae were sampled off the east coast of Scotland in January-February (D.W. Armstrong, A.W. Newton).

Experimental Work - Zooplankton. Secondary production studies with particular reference to the feeding of herbivorous copepods have been continued during 1973. The work fell into the following categories (i) estimates of feeding rates on natural phytoplankton populations of Copepods from Loch Ewe and the Clyde region (J.C. Gamble, D.D. Seaton). (ii) feeding behaviour and population structure in the plastic column experiment at Loch Ewe (J.C. Gamble, D.D. Seaton), (iii) conclusion of studies of the effects of copper and mercury on copepod feeding behaviour (R.W. Foster). The study of the effects of pollutants on herring larvae has also been continued (I.G. Baxter).

Experimental Work - Phytoplankton. Investigations into effects of pollutants on cultured phytoplankton species were started in 1973. Several species have been successfully kept in culture; a chemostat is being set up and fluorescent microscopy is being used to determine viability in phytoplankton populations (J.A. Mowat, S.M. Reid).

Heavy metals in zooplankton. Further samples were obtained from the Firth of Clyde for the determination of the levels of copper, zinc, lead and cadmium in various size components of the catch and in various individual species, (G. Topping, J.M. Pirie, W.C. Graham).

The programme for 1974. A large part of the 1974 programme will be similar to that of previous years. The most important new development will be a detailed study of the ecology of gadoid larvae. This will be in two parts.

During April a detailed transect will be sampled along  $0^{\circ}30'E$  from about  $58^{\circ}N$  to  $61^{\circ}N$ . Samples will be obtained both at fixed stations and while underway to give estimates of the abundance of both the larvae and the microzooplankton. Chemical parameters and chlorophyll measurements

will give details of the spring outburst while temperature and salinity observations, together with the results from 6 current meter rigs, will give information on the hydrographic background (J.H. Steele, R. Jones, R.C. Minton, D.V.P. Conway and others).

The complementary studies will be carried out at Loch Ewe. It is proposed that about 1 000 whiting larvae will be introduced in early May to each of 4 large plastic columns ( $120 \text{ m}^3$ ) in Loch Ewe. The larvae should then be at the end of the yolk sac stage and their survival, growth etc will be followed for a period of up to 50 days. Frequent monitoring will also be carried out of physical, chemical and biological parameters (J.H. Steele, R. Jones, R.C. Minton, J.C. Gamble and others).

Other experimental work for 1974 and beyond will include (i) technique development and improvement (ii) attempts at estimating the role of smaller zooplankton and benthic larvae (cirripeds) in secondary production (iii) continuation of plastic column experiments (iv) interspecific differences in feeding behaviour (v) commencement of studies on planktonic carnivore feeding (vi) continuation of the studies of the effects of pollutants on cultured phytoplankton species.

## 2. Oceanographic Laboratory, Edinburgh (IMER)

The Continuous Plankton Recorder Survey. The survey by the Continuous Plankton Recorder was continued in 1973 on the same basis as in previous years. Recorders are towed at a depth of ten metres at monthly intervals along the standard routes shown in Figure 1.

During the past year, Recorders were towed for 117 000 miles by 35 ships of eight nations. The present survey has been in operation since 1948, and since then the plankton has been collected and the results have been processed in exactly the same way. The data processing system has been fully computerised since 1963 and full details, together with examples of computer output are given by Colebrook (Bull. mar. Ecol.,

in the press). Further details may be obtained on application to the Oceanographic Laboratory, 78 Craighall Road, Edinburgh EH6 4RQ.

The Plankton Indicator Survey. Studies of the planktonic environment of the herring fisheries off the north-east coast of Scotland were continued in 1973. Samples have been taken regularly from fishing vessels, and research vessels of the Department of Agriculture and Fisheries for Scotland and the Ministry of Agriculture, Fisheries and Food.

Ocean Weather Ship Programme. An oceanic modelling experiment has been maintained at Ocean Weather Station INDIA (59°00'N 19°00'W) since March 1971. Scientists worked on board Ocean Weather Ships on duty at INDIA from March to October 1973.

Measurements were made of:-

- (a) the vertical distribution of the zooplankton in the upper 500 metres using Longhurst Hardy Plankton Recorders.
- (b) primary productivity ( $^{14}\text{C}$  method), chlorophyll concentration and phytoplankton (species counts) in the upper 100 metres.
- (c) salinity, temperature and nutrients in the upper 200 metres.
- (d) organochlorines and heavy metals in the plankton
- (e) solar radiation and light attenuation in surface water.

All programmes are supported by the U.K. Natural Environment Research Council.

### 3. Dunstaffnage Marine Research Laboratory (SMBA)

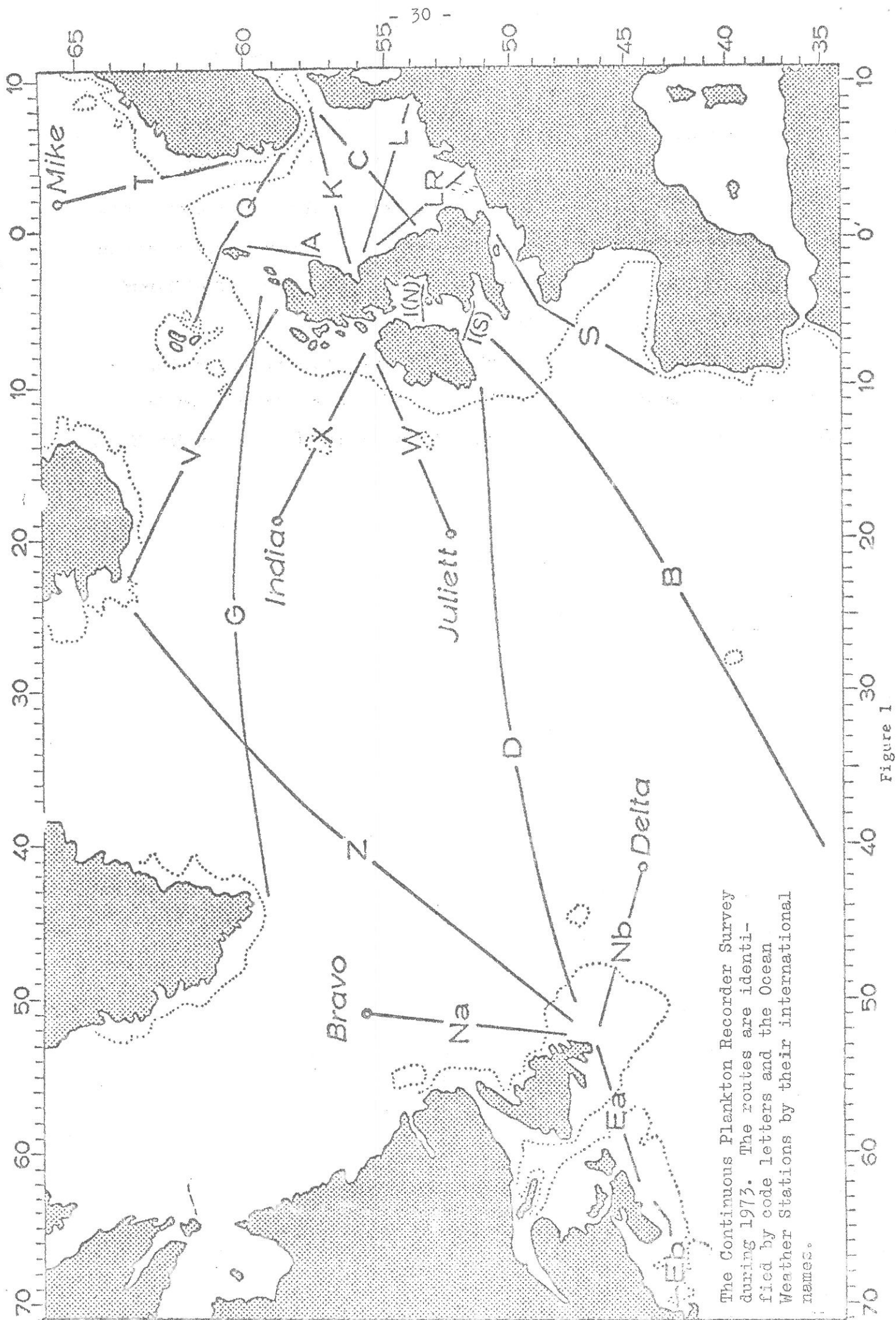
Phytoplankton production and ecology. Phytoplankton standing crop, species and chemical composition, and production in relation to nutrients in Loch Creran (P. Tett, joint programme with B.J.B. Wood, University of Strathclyde, Department of Applied Microbiology).

There were two cruises to investigate phytoplankton standing crop and production in the Argyll sea lochs (P. Tett and B.J.B. Wood).

The biology of Pareuchaeta norvegica. The biology of P. norvegica in Loch Etive and near  $55^{\circ}\text{N}$   $12^{\circ}\text{W}$  is being investigated (Miss H. Grigg).

Bathypelagic plankton. Samples of the bathypelagic plankton were collected at 2000 - 3000 m depth near  $55^{\circ}\text{N}$   $12^{\circ}\text{W}$  in July, November and December and in the Bay of Biscay in May. The taxonomy, breeding and growth of different species are being studied (J. Mauchline, Miss H. Grigg).

Programme for 1974. The work described above will be continued while, in addition, quantitative studies of zooplankton micro-distribution in Loch Etive and the Firth of Lorne will be carried out (Marjan van der Eijk).



The Continuous Plankton Recorder Survey during 1973. The routes are identified by code letters and the Ocean Weather Stations by their international names.



United States

(K. Sherman)

1. ICHTHYOPLANKTON SURVEYS

1.1 MARMAP Program

1.2 MARMAP Operational Test Phase Cruises -- Atlantic

1.3 Joint International Surveys

1.4 Atlantic Coastal Surveys

1.5 Gulf of Mexico Coastal Surveys

1.6 Eastern Pacific Surveys

2. ENVIRONMENTAL RELATIONSHIPS: PLANKTON/ICHTHYOPLANKTON

2.1 Larval Survival

2.2 Ecosystem Dynamics

2.3 Anchovy Predation

2.4 Anchovy Feeding

2.5 Marine Contaminants and Zooplankton

3. TAXONOMY AND ZOOGEOGRAPHY OF LARVAL MARINE FISH

3.1 Atlantic

3.2 Pacific

4. TECHNICAL ADVANCES

4.1 Plankton Sorter

4.2 Shipboard Autoanalyzer

4.3 Undulating Oceanographic Recorder

4.4 Ichthyoplankton Samplers

4.5 MARMAP I-K trawl

## 1. ICHTHYOPLANKTON INVESTIGATIONS

### 1.1 MARMAP Program

MARMAP is a nationally coordinated program of the National Marine Fisheries Service to monitor, assess, and predict the kinds and quantities of living marine resources present in selected ocean areas, and to provide a comprehensive data base for effective management of these resources. Surveys are conducted for ichthyoplankton, groundfish, and pelagic fish to determine the spatial and temporal extent of their populations using standard sampling methods and data reporting techniques. The surveys support comprehensive analysis of the effects of fishing on resource populations, and other biological and oceanographic studies conducted by NMFS, universities, and other Federal, state, and international organizations. Environmental groups of NMFS collate and analyse environmental data for describing changes in currents, water masses, water types, upwelling, and other significant events. In 1972 principal ichthyoplankton survey operations included the area from the Gulf of Maine to the Caribbean in the Atlantic and in the California Current and Gulf of Alaska in the Pacific.

### 1.2 MARMAP Operational Test Phase Cruises - Atlantic

During July-August 1972 an initial MARMAP survey for ichthyoplankton was conducted in the waters from Cape Cod to the Caribbean to: (1) test the MARMAP data acquisition, reduction, and analyses system during a multi-ship operation; (2) determine the spawning locations and the effects of the Gulf Stream system on the distribution of fish eggs and larvae of important gamefish (tuna, marlin, sailfish, bluefish, jacks) and commercial species (herrings, cod, flounders, mackerels, and others); and (3) investigate the relationships between nutrients and ichthyoplankton concentrations. Participating vessels included the "Albatross IV" from the Northeast Fisheries Center, Woods Hole, Massachusetts; "Delaware II" from the Mid-Atlantic Coastal Fisheries Center, Sandy Hook, New Jersey; and "Oregon II" operated by the Southeast Fisheries Center, Miami, Florida. A survey designed to sample distributions of larval fish in the Gulf Stream system in winter (January-March) was completed in March 1973.

Participating vessels included "Albatross IV," "NEFC;" "Dolphin," South Carolina Marine Resources Department; "Oregon II," "SEFC;" Trident, University of Rhode Island; and "Wieczno," Polish Sea Fisheries Laboratory.

On the survey standard sampling procedures were followed using paired 60 cm plankton nets (bongos) fitted with 0.333 and 0.505 mesh apertures and towed obliquely from the surface to 200 meters. Neuston collections were made with a 1x2 M rectangular frame fitted with 0.947 mm mesh apertures. Environmental observations included hydrographic casts for temperature and salinity to 1000 meters and at selected locations measures of nutrient loads (nitrate, silicate, phosphate), ammonia, chlorophyll, and standard meteorological measurements.

Initial findings of extensive contamination of surface waters with tar clumps and plastic spherules and discs was unexpected. Greatest concentrations of tar (ca. 4800 mg/1000m<sup>2</sup>) were in the western boundary of the Sargasso Sea off the Bahamas; plastics were in heavy concentrations (ca. 130 mg/1000m<sup>2</sup>) in coastal waters from Virginia to Cape Cod. A total of 78 000 larvae representing 110 families were in the July-August samples; myctophiids and gonostomids dominated the oceanic larval biomass; other abundant groups included gadids, mostly red hake (Urophycis) from Cape Cod to Delaware Bay, herring (clupeids) and anchovies (engraulids) from Cape Cod to Cape Kennedy, bluefish (pomatomids) in heavy concentrations within 100 miles of the coast between Cape Hatteras and Delaware Bay, mackerels (Scomberomorus spp.) from Cape Henry to Cape Kennedy, and Atlantic mackerel (Scomber scombrus) from Cape Hatteras to Cape Cod. Spawning areas of other important stocks were located in oceanic waters - blue marlin (Makaira nigricans) stocks northeast of the Bahamas and in the eastern Gulf of Mexico; swordfish (Xiphias gladius) in the Gulf Stream off Cape Kennedy; flying fish (exocoetids) in the Gulf Stream; and blackfin tuna (Thunnus atlanticus) in the central Caribbean.

### 1.3 Joint International Surveys

ICNAF -- A joint larval herring survey with Canada, France, Federal Republic of Germany, and the U.S.S.R. was completed in Autumn 1972 in the Georges Bank - Gulf of Maine area. All participants used standard MARMAP

bongo samplers for the larvae. Initial results suggested that oceanographic conditions favoured the conservation of larvae of mixed sizes in the areas of initial spawning. Another joint survey to investigate larval dispersal and population integrity is planned for Autumn 1973. CICAR -- A series of instructional seminars on the use of bongo and neuston samplers in surveys of fish eggs and larvae was conducted on the NOAA vessel "Discoverer" on a spring cruise through the Caribbean as part of the CICAR program. EASTERN PACIFIC HAKE -- Cooperative surveys were conducted in February with the Soviet research vessel "Alba," to the north of the hake spawning and the Mexican research vessel, "Humboldt," to the south of the spawning area with the NMFS research vessel "David Starr Jordan," and the SIO research vessel, "Alexander Agassiz," covering the usual center of the hake spawning off southern and Baja California. The survey encompassed the spawning of Pacific hake and provided sufficient data for estimating the size of the parent stock. JAPAN -- Sea trials of the bongo sampling array were completed by Japanese scientists from the University of Hokkaido during ichthyoplankton sampling in the East Bering Sea in Spring 1972 on the Oshoro maru, and in the central Pacific during Winter on the "Kaiyo maru" of the Japanese Far Seas Laboratory, Shimizu. UNITED KINGDOM -- A scientific group has been established by NMFS in Narragansett, R.I., to maintain and service Continuous Plankton Recorders on U.S. Coast Guard transects to ocean stations DELTA and BRAVO; approximately 1 000 miles of plankton records per month are forwarded to the Institute for Marine Environmental Research, Plymouth. Analysis has been completed on 2 400 miles of plankton record collected from Cape Cod to the Caribbean during MARMAP Operational Test Phase surveys. Plans have been developed for extending the CPR Coverage from Halifax and New York to Bermuda on a monthly sampling schedule. MEXICO -- Intercomparisons of Mexican and U.S. ichthyoplankton and oceanographic sampling methods were made by the staff of the Southwest Fisheries Center, La Jolla, in a common area of the CalCOFI grid in preparation for joint CalCOFI and Instituto Nacional de Pesca (INP) work on assessing and monitoring of the pelagic fish resources off the Pacific coast of Baja California. The number



and sizes of anchovy larvae and hake larvae, number of anchovy eggs and the displacement volume of the total catch of plankton will be the primary criteria for evaluating the cooperative work. In all, 14 stations will be used from three cruises in the south Baja inshore and offshore regions; this constituted a zone of overlap of 23 000 square miles of survey area. Comparison of oceanographic data will be conducted later. An INP sorting and identification laboratory is being established in Mazatlan. Present plans include continuing technical assistance from the La Jolla Laboratory plankton sorters, and identifiers when the Mazatlan Laboratory is established; also, there will be continued joint cruises and exchange of sea-going personnel. POLAND -- A joint NMFS-Sea Fisheries Institute Plankton Sorting Center is planned for establishment at Stettin (Szczecin). Technical assistance will be provided by the MARMAP Field Group and Northeast Fisheries Center. Principal investigations will be concerned with fish stock assessments and food chain dynamics.

#### 1.4 Atlantic Coastal Surveys

Collections of larvae and juveniles of important fish stocks (flounders, sea basses, bluefish, and others) in the mid-Atlantic Bight are made by the staff of the Middle Atlantic Coastal Fisheries Center, Sandy Hook, N.J. Investigations in 1972 focused on the mechanisms effecting the inshore-offshore transport of larval and juvenile recreational and commercial species in an attempt to document the movements of the species from offshore spawning sites to estuarine nursery grounds. Advective mechanisms responsible for the seasonal influx of larval menhaden were under investigation by the Atlantic Estuarine Center at Beaufort, North Carolina. Monthly sampling of ichthyoplankton was made in the vicinity of Onslow Bay, North Carolina, using standard bongo sampling methods and reporting procedures; offshore sampling off the Carolinas revealed the presence of heretofore unsuspected concentrations of menhaden larvae 60 to 100 miles offshore in early winter.

#### 1.5 Gulf of Mexico Coastal Surveys

The monthly ichthyoplankton survey of Tampa Bay and adjacent coastal waters was continued in 1972 by staff of the Gulf Coastal Fisheries Center,

St. Petersburg, Florida, using standard 20 cm bongo samplers. Plankton volumes and fish eggs and larvae diminished on a seasonal basis reaching a low in December when spawning is completed in Tampa Bay although some fish species are still spawning in the Gulf of Mexico. The dominant species in Hillsborough and Old Tampa Bays were striped anchovy, Anchoa hepsetus; lined sole, Achirus lineatus, and searobins, Prinotus spp. The dominant larval families included Sciaenidae, Blenniidae, Triglidae, and Soleidae. In the coastal waters adjacent to Tampa Bay commonly occurring species were the black drum, Pogonias cromis; red drum, Sciaenops ocellata; spotfin mojarra, Eucinostomus argenteus; puffer, Sphoeroides spp; spotted seatrout, Cynoscion nebulosus, leopard searobin, Prinotus scitulus; and the southern kingfish, Menticirrhus americanus. Eggs of the searobin and sole were hatched and larvae reared in the laboratory. Preliminary sorting and identification of the larvae collected on a quarterly basis from the Everglades during 1971 and 1972 was 95 percent completed during the quarter. All larvae are being taken to family level and when possible to genus and species. Larval series were photographed for later publication. The dominant groups are the sciaenids, carangids, engraulids, clupeids, gerrids, and pomodasids.

All larval and postlarval fish from 3 years (January 1970-December 1972) of biweekly postlarval shrimp samples collected near the north jetty of Galveston Entrance have been sorted and identified by the staff of the Gulf Coastal Center, Galveston, Texas. A total of 19 751 fish and 2 395 chaetognaths were identified from samples collected in 1970, and the total for 1971 was 22 164 organisms. Thirty-one families and 69 species were represented in the 1970 and 1971 samples.

#### 1.6 Eastern Pacific Surveys

A CalCOFI\* cruise by staff of the Southwest Fisheries Center, La Jolla, California, to collect ichthyoplankton and hydrographic data in a continuing investigation of the California Current and adjacent eastern Pacific waters was completed in Spring from off southern California to Mazatlan, Mexico. Comparative bongo and CalCOFI net tows were made as part of a comprehensive intercalibration experiment. The analysis of the long-term CalCOFI record of the spawning of pelagic fish in the California Current area is being completed

in four phases: (1) the definition of spawning areas, (2) the definition of spawning seasons, (3) a "sampling-effort-stabilized" estimate of mean abundance of larvae and eggs, and (4) the variability of the regional estimates of abundance. The spawning records for northern anchovy, Pacific sardine, Pacific hake, Pacific mackerel, and jack mackerel have been analyzed; hake spawn only in the winter quarter, the anchovy spawns in the winter quarter and spring quarter, the jack mackerel and sardines spawn predominantly in the spring quarter with some spawning in the summer quarter. The Pacific mackerel spawn predominantly in the summer quarter. When the effects of trends are reduced it appears that the proportional variance will be inversely proportional to the mean number of larvae. The relationship between secondary production and recruitment is being investigated for several important populations. The stock-recruitment ratios for sardines and other zooplanktivorous fishes in the California Current appears to vary by 10-20 times on an annual basis with some degree of autocorrelation. A similar degree of variation and autocorrelation in the rate of the spring increase in zooplankton biomass in the spawning areas has also been noted. These rates of spring increase in turn appear dependent on rates of surface transport and upwelling. Studies of biological indicators—chaetognaths, siphonophores, and medusae-- of California Current and other North Pacific water masses and water types is continuing using the CalCOFI\* collections as a principal data source.

MARMAP operational test phase surveys of the ichthyoplankton in the Gulf of Alaska were completed by the staff of the Northeast Fisheries Center on the RV Kelez in Spring using standard sampling and reporting methods. In the vicinity of Kodiak Island the dominant species were walleye pollock (Theragra chalcogramma) constituting 65% of the total larval biomass, followed by sand lance Ammodytes hexapterus (13%), cottids (7%), pleuronectids (7%), and others. Species composition in surveys near the Washington coast described a faunal assemblage dominated by osmerid smelts (26%); gadids, Microgadus proximus (24%); and flounders (39%) (principally pleuronectids). Amphipods

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\* California Cooperative Fisheries Investigations

sampled during "Kelez" operations in the Gulf of Alaska have been identified. The samples contained 41 species from 30 genera in 19 families. Hyperiidea was the dominant suborder both in abundance and numbers of species. Copepods in selected samples have also been identified. Forty-one species in 25 genera from 20 families were found.

## 2. ENVIRONMENTAL RELATIONSHIPS

### 2.1 Larval Survival

Investigations on the effects of environmental changes on the survival of the larvae of important resource stocks is continuing on a number of species at NMFS laboratory facilities. At the Northeast Fisheries Center staff investigators are conducting experiments on the response of selected groundfish species (herring, flounder, scup, cod, haddock and lobster) to changes in temperature, salinity, oxygen, and food abundance. Recently completed feeding studies with larval haddock, Melanogrammus aeglefinus, at five prey concentrations (3.0, 1.0, 0.5, 0.1, and 0.01 plankters/ml) indicated that survival in the six weeks following hatching was dependent on feeding level with prey concentrations > 0.5 zooplankters/ml (principally the copepods Acartia spp. and Eurytemora spp.) Delayed feeding experiments established the point-of-no-return as day 8 at 10°C and 10 days at 7°C; winter flounder, Pseudopleuronectes americanus, initiated feeding 6 days after hatching at 5°C and 4 days at 8°C; at both temperatures the "null return" was at day 10.

### 2.2 Ecosystem Dynamics

Staff of the Atlantic Estuarine Fisheries Center, Beaufort, N.C., are investigating (1) the effects of thermal shock on larval estuarine fish, and (2) the energetics of estuarine ecosystems. In 1972 critical thermal maximum (CTM), oxygen consumption, survival, and behavior of larval fish were measured as a function of the magnitude of temperature change, exposure time, and salinity for larvae of Atlantic menhaden (Brevoortia tyrannus), spot (Leiostomus xanthurus), pinfish (Lagodon rhomboides) and 3 species of flounder (Paralichthys spp.) Measurements of CTM were inadequate for evaluating



the effects of entrainment on larval fish, although they were useful in establishing ranges of thermal tolerance. Oxygen consumption of larval fish responded quickly to thermal shock. The response was dependent on the magnitude and direction of the temperature change. Survival was dependent on magnitude of temperature change, length of exposure, salinity and species of fish. Observations on behaviour of the experimental fish indicate that at least two shocks are discernible during entrainment: one when the fish passes from environmental temperature to the entrainment temperature and a second when the fish passes back to the environmental temperature. The results of these experiments are used to evaluate the possible effects of entrainment on larval fish populations in estuarine waters.

Analysis of the distribution of energy, carbon, and nitrogen in the flora and fauna of the Newport River estuary is continuing to provide information for modeling the distribution and seasonal changes in the distribution of the biota. Plankton, nekton, and benthonic organisms are collected; live weights, dry weights and ash-free dry weights are measured; and for each species and each size class the caloric content are measured. Organisms are supplied by ongoing Center projects and supplemented where necessary by extra sampling. Fat is estimated from the following: dry weight minus ash weight minus (nitrogen content x 6.25). One complete life history analysis to date has shown that for pinfish (Lagodon rhomboides) there is a seasonal variation in all parameters, size class differences, and seasonal differences in these parameters within certain size classes. These differences are ascribed to changes in feeding patterns and physiology. This suggests variability in the nutritive value of these organisms to the next trophic level; similar observations also were noted with zooplankton. Available information concerning the ecosystem in the Newport River estuary is being integrated into preliminary (biomass) models representing flows of energy and materials. Efforts initially were directed to carbon but now the focus is on nitrogen and energy. Descriptive models now in preparation will provide a basis for determining whether carbon, nitrogen, or energy are limiting or controlling factors in the system.

### 2.3 Anchovy Predation

Experiments on predation by euphausiid shrimps on anchovy larvae were completed at the Southwest Fisheries Center, La Jolla; 350 experiments were run with Euphausia pacifica, the most abundant euphausiid found in the California Current. This animal migrates to the surface nightly and feeds where anchovy larvae are most abundant. The maximum number of early anchovy larvae that juvenile (7-8 mm) Euphausia pacifica consumed per day in the predation experiments was 27. E. pacifica this size are about 2-3 months old: after 1 year, the maximum euphausiid size is 22-24 mm. The median number of prey-eaten-per-young-euphausiid was established in a series of over 50 experiments in which the number of larvae offered was increased from 1 to 50. When the euphausiids were fed 20 or more larvae the median number eaten was 11. The filtering rate required to collect 11 larvae if 40-50 are offered is 43 ml/hr; it is 100 ml/hr when 20-30 larvae are fed. The volume searched increased to 200 ml/hr for euphausiids fed less than 11 larvae and in 30% of these experiments all of the larvae offered were eaten.

### 2.4 Anchovy Feeding

Experiments designed to determine if yolk-sac anchovy larvae are able to locate and remain in areas of high food concentrations were also completed at the SWFC: 100 anchovy eggs were added to 10-litre containers in which a patch of the dinoflagellate, Gymnodinium splendens, had been established. (Gymnodinium will form dense patches beneath a light and the patches will persist for periods of up to 2 weeks after the light is removed.) Two days later, when the larvae were 1 day old the entire patch and the larvae that it contained were removed from the container. Four control samples having the same volume as the one enclosing the patch were also taken from the same container. Water samples containing a patch of Gymnodinium contained more larvae ( $P < 0.001$ ) than did water samples without a patch although the rest of the water had a relatively high density of Gymnodinium (1-175 cells/ml). Further analysis showed that the numbers of larvae attracted was a function

of the concentration of food organisms and volume of the patch. On the average, 30% of the larvae added to a container were in the food patches within 24 hours if the patch had a density of 3 000 Gymnodinium cells/ml and a volume of 800 ml, whereas 13% could be expected if the volume of the patch was only 500 ml and had a density of 1 000/ml. The number of larvae expected to occur by chance alone would be about 8% for the 800 ml patch and 5% in the 500 ml patch.

## 2.5 Marine Contaminants and Zooplankton

Analysis by the staff of the SWFC of chlorinated hydrocarbons (CHC) in Longhurst-Hardy Plankton Recorder records shows that zooplankton samples taken at different depths at the same station contain about the same CHC concentration in their lipids despite an order of magnitude change in zooplankton density. In addition, CHC concentration did not vary appreciably with species. These results imply that zooplankton can be used as probes for CHC concentration in the ocean as a whole. Analysis of whole water extracts and filtrates has shown that most of the California Current's burden of CHC is absorbed on particulate material smaller than 0.5 micron or is in solution. Polychlorinated biphenyls (PCB), the principal CHC contaminants, fall in the range 1 to 10 parts per trillion. Although CHC levels in slicks are as much as an order of magnitude higher than in the bulk water, the total amount in this top millimeter is inconsequential compared to the amount in the rest of the water column. Natural slick-forming materials appear to play little part in the solution of CHC since levels in natural slicks are the same the levels in adjacent non-slick areas.

Data on DDT and PCB contamination of zooplankton was contoured and plotted in the California Current region for the year 1969. The DDT distribution exhibits a hot spot in Santa Monica Bay off Los Angeles and generally decreases uniformly with distance from shore from  $10^{-8}$  g in zooplankton per cubic meter of ocean, to one-tenth this value 200 miles offshore. The Santa Monica Bay level was  $2 \times 10^{-6}$  g DDT in plankton/m<sup>3</sup>. The PCB distribution showed highest levels (between  $0.5 \times 10^{-6}$  and  $1.5 \times 10^{-6}$  g/m<sup>3</sup>) at stations located 60-120 miles

offshore. These regions include a large (200 x 80 miles) area extending from San Francisco to Point Conception and two areas 60 miles west of both Santa Monica and San Diego. With the exception of high values ( $0.7 \times 10^{-6} \text{ g/m}^3$ ) found in Vizcaino Bay, levels decreased with distance from San Francisco both north and south. Comparisons will be made with analyses of samples taken after chemical plant dumping ceased in the Los Angeles Bight to determine at what rate the ecosystem is recovering from DDT contamination by this central source.

### 3. TAXONOMY AND ZOOGEOGRAPHY OF LARVAL MARINE FISH

#### 3.1 Atlantic

The ichthyology project at the Southeast Fisheries Center, Miami, has as its mission the investigation of the ecology and early life history of fishes. The basis for this research is the collection and rearing of marine fish from eggs and the study of the environmental influences on these critical life history stages. The rearing provides not only specimens for experimental work but also provides a larval series for the basic descriptive work and a series for the identification of eggs and larvae of field surveys such as MARMAP.

Program personnel have reared over 70 species including 17 species of sport fishing interest and 14 species of some commercial importance. Local egg collections from the Gulf Stream and upper Florida Keys areas are being made at least twice a month to ascertain seasonal abundance and distribution.

Such carangids as the Florida pompano, Trachinotus carolinus, and the permit fish, T. falcatus, have been reared. The haemulids (grunts) sailor's choice (Haemulon parrai), white grunt (H. plumieri), and bluestriped grunt (H. sciurus) were also reared. Reared sciaenids (drums), such as Atlantic croaker (Micropogon undulatus), kingfish (Menticirrhus sp.) and spotted seatrout (Cynoscion nebulosus) are of both commercial and sport fishing importance. Rearing of tunas and mackerels (Scombridae) such as the wahoo, Acanthocybium solanderi; frigate mackerel, Auxis A and B (two distinct eggs but presently only 1 species is recognized); little tunny, Euthynnus alletteratus; skipjack,



Euthynnus pelamis; chub mackerel, Scomber japonicus; king mackerel, Scomberomorus cavalla; and the cero mackerel, S. regalis, was very successful. In limited numbers, and for the first time, the blackfin tuna, Thunnus atlanticus, was reared.

Two species of Lutjanids (snappers) were reared in the laboratory under different food densities and light levels. Eggs of Lutjanus griseus, gray snapper, obtained both from the field collections and a commercial source were found to grow well in full light with low food levels (1 food organism per ml). The yellowtail snapper, Ocyurus chrysurus, obtained from a commercial supply also grew well in low food levels.

Temperature and salinity tolerances have been evaluated for juveniles of the Florida pompano, Trachinotus carolinus. Temperature tolerances for eggs and larvae of the pompano were also studied. The pompano has a broad salinity range, but the temperature tolerance indicates that it exists close to its upper temperature limit in the Florida area. Eggs and larvae have a much narrower range ( $26^{\circ}\text{C}$ - $33^{\circ}\text{C}$ ) than do juveniles ( $9^{\circ}$ - $30^{\circ}\text{C}$ ).

Temperature tolerances were also investigated for the eggs and larvae of the little tunny, Euthynnus alletteratus. The range of this scombrid was  $21^{\circ}$ - $34^{\circ}\text{C}$  with the best survival at  $27^{\circ}\text{C}$ . The clupeoid fishes, Anchoa mitchilli, Harengula pensacolae, and Sardinella anchovia showed a broader range of temperature tolerances ( $16^{\circ}$ - $35^{\circ}\text{C}$ ) but higher survival percentages occurred from  $20^{\circ}$ - $34^{\circ}\text{C}$ . The pinfish, Lagodon rhomboides, was tested from  $16^{\circ}$  -  $33^{\circ}\text{C}$  and exhibited good survival percentages up to  $30^{\circ}\text{C}$ .

### 3.2 Pacific

The ichthyoplankton project at SWFC carries out three primary activities:

- (1) description of early life history stages of fishes of the California Current (CalCOFI) region and adjacent areas of the eastern Pacific; (2) identification and enumeration of ichthyoplankton (fish larvae and juveniles) from wider ranging survey cruises in the eastern Pacific, such as EASTROPAC and NORPAC as a means of evaluating the kinds of fishes, their relative abundance, spawning season,

distribution in relation to oceanographic features such as water masses, etc.; and (3) serves as a training center in larval fish taxonomy for service personnel, foreign scientists supported by FAO or UNESCO, and students.

Progress was made on the study of rockfishes (Sebastes) and related scorpaenid fishes (Scorpaenodes, Scorpaena, Sebastolobus, Pontinus, Helicolenus) in the eastern Pacific. A list of meristic characters, including vertebral number, for all the known species of these genera was compiled. Samples from tropical-subtropical cruises (EASTROPAC, Scripps Tuna Oceanography, CalCOFI) were searched for larvae of Scorpaenidae. The meristic characters and other characters of the adults were used to identify them. The larvae of all scorpionfishes in the eastern Pacific can now be identified at least to genus. Some common species (Scorpaenodes xyris, Pontinus sierra) can be identified and progress is continuing on the specific identification of the remainder of the fauna. These results will be assembled into a MARMAP identification guide to be issued as a Circular.

Work is continuing on the second part of a monograph on the lanternfishes of the California Current region. Species of the genus Lampanyctus are now under study. A developmental series of L. regalis was measured to produce a table of morphometric measurements. The series was photographed and drawings are in preparation. A set of characters that allows the separation of small larvae of Lampanyctus regalis from larvae of the closely related species L. ritteri and L. idostigma was established. The latter two species also will be included in the second part of the monograph.

Lampanyctus is the second largest genus in the family Myctophidae, and the most difficult in which to establish developmental series. The difficulty arises from the lack of larval characters, such as early-forming photophores and from the similarity in meristic characters among species of Lampanyctus. A number of previously difficult to obtain specimens of late larvae, transformation stages and early juveniles of myctophids from the offshore coastal water mass, collected on Arica 9 expedition by SIO with Isaacs-Kidd (IK) trawl gear, and were made available by SIO. This material, together with the Isaacs-Kidd MARMAP net collections have provided material for a complete

larval series of several species of Lampanyctus, including those of an undescribed species.

Identification of billfish larvae collected on past cruises in the central and west Pacific vessels of the Honolulu Laboratory, SWFC, were verified. First indications are that published identification of blue marlin, shortbill, spearfish, sailfish, and striped marlin larvae are correct, but that the descriptions of characters used for separating blue from striped marlin need to be more clearly defined. Specimens of larval, juvenile, and adult fishes are under investigation to obtain information on the development of the caudal fin and on its supporting bones to determine the value of developmental characters of this fin (one of the most conservative in fishes) in larval fish identification and in evaluating fish phylogeny.

#### 4. TECHNICAL ADVANCES

##### 4.1 Plankton Sorter

A prototype automated plankton sorting system is being developed; in cooperation with Rutgers University, the staff of the Northeast Fisheries Center, Narragansett, R.I., demonstrated that fish eggs and larvae can be separated from invertebrate plankton by isopycnic sedimentation in gradients of Ludox, an osmotically inactive inorganic silica colloid. Experiments are continuing with differing concentrations of Ludox and trimetaphosphate and different zooplankton constituents to develop a practical guide for settling rates of a wide variety of zooplankton. The prototype sorting system will include a linear gradient generator and a multicolumn one-g gradient element, which will allow for piston fluid discharge of gradient fractions.

##### 4.2 Shipboard Autoanalyzer

Experimentation is continuing with a shipboard autoanalyzer system for phosphates, silicates, ammonia, and nitrates.

##### 4.3 Undulating Oceanographic Recorder

In cooperation with the United Kingdom, the field testing and evaluation of the prototype Undulating Oceanographic Recorder is in progress.

#### 4.4 Ichthyoplankton Samplers

Final sea trials of the MARMAP bongo sampling system were completed in 1972. Bongos were more efficient samplers than other samplers of the same mesh size tested (CalCOFI net, SCOR/UNESCO Working Group 3 net, and enclosed Gulf III sampler). The bongo reduces avoidance, extrusion, clogging and provides a smoother tow profile than other samplers tested at every speed of tow examined (1.5, 3.0, 4.5 knots). Based on these results the bongo array has been designated as the standard MARMAP ichthyoplankton sampler; a complete array includes paired 60 cm bongos with one net of 0.505 mm mesh and its pair of 0.333, flowmeters, a time-depth recorder, and a 45 kg weight. Details of its deployment are given in the "contributions to a manual on fish egg and larval surveys,"<sup>1</sup> prepared under the direction of FAO.

#### 4.5 MARMAP I-K Trawl

Tests were made to evaluate the Isaacs-Kidd midwater trawl by the staff of the Southwest Fisheries Center. A group of eleven samples was taken on November 12-14, 1971, northeast of Hawaii by the Research Vessel "Alpha Helix" to test the net's potential as a standard collecting device for MARMAP. The species collected are typical deep-sea fishes of the North Pacific central water mass, with myctophids and gonostomatids accounting for upwards of 90% of the specimens. No larvae were obtained of tunas or other fishes of commercial importance. The condition of specimens was poorest in hauls taken at 6 knots, with a portion of the material too damaged to identify; best in hauls taken at 4 knots. These hauls provided larger larvae and transforming specimens that are not commonly taken in plankton hauls, hence can be an important collecting tool for life history studies.

<sup>1</sup> Preliminary draft issued July 1973 edited by Dr. G. Hempel.

U.S.S.R.  
(A.S. Bogdanov)

In 1973 the investigations into phyto- and zooplankton organisms of the Barents and Norwegian Seas were continued. These researches are aimed at the assessment of food resources of commercial fishes and its importance for the formation of their abundance. This year 75 phytoplankton and 2 440 zooplankton and 540 Euphausiacea samples were collected.

Due to observations on the spring development of plankton in the southwestern Barents Sea the analysis of correlation between plankton abundance and average water temperature for the same years ( $r = 0.72$  at reliability  $= 0.99$ ) was carried out.

In the south-eastern part of the Barents Sea a high abundance and concentration of Euphausiacea was revealed, that was caused by an extraordinary intensive breeding of the species Thysanoessa raschii.

It was pointed out that food spectrum of blue whiting was the same as that of the Atlantic herring, but the annual consumption amounted to 35-50% of the whole zooplankton production.

The assessment of the survival of the plankton - feeding fry of the Barents Sea cod of the 1972 year class was completed.

In 1974, the investigations in the Barents and Norwegian Seas will be conducted according to the previous programme.

#### Baltic Sea

The zooplankton composition, distribution, its diurnal migrations by seasons, areas, depth ranges and the character of its using by Baltic herring and sprat were also investigated in the Baltic Sea, Gulfs of Riga and Finland. The ecology and the population dynamics of Limnocalanus grimaldii and Bosmina coregoni were studied in order to elaborate methods of forecasting sizes of their stocks. The tests of growing Eurytemora hirundoides were made and their metamorphosis stage was determined in the laboratory conditions. Population



dynamics and the age composition of Mysidae in the north-eastern part of the Gulf of Riga were investigated as well. Floristic composition, distribution and the ecology of the bottom algae growing in the Gulf of Riga and along the shore of the Gulf of Finland, and supply of Furcillaria in the north-eastern Baltic were studied as well.

In 1974, the development of these trends of investigations will be continued.





Plankton Committee

German Democratic Republic

(Dr. Sigurd Schulz)

North Eastern Central Atlantic

During the 5 th Expedition of the R.V. "Alexander von Humboldt" (Nov. 06 1972 - April 26 1973) to the upwelling region off NW Africa in the frame of the oceanographical programme investigations of the phyto - and zooplankton were carried out.

The investigations have been focussed on the determination of the phytoplankton productivity, the spacial and temporal distribution of the phyto- and zooplankton and their biomasse in dependence on the upwelling and other oceanographical factors.

Baltic Sea

Within the long-term oceanographical investigations in the Baltic also plantological work was done. At 5 cruises in February, March/April, May, August and October/November data on primary productivity and qualitative and quantitative distribution of the phyto- and zooplankton have been performed.

